Pyrite Analysis of an Ordovician Phosphate Rock Core from Southern Indiana

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Understanding the depositional environments that preserve phosphate-rich rock is becoming progressively more important in light of the increasing scarcity of phosphorus. Phosphorus is the primary constituent in one of the most common types of fertilizer, and it is also used in industries ranging from semiconductor production to flame retardant clothing. Phosphate beds are currently accumulating along select active and passive coastal margins through oceanic upwelling. Upwelling occurs when cold deep phosphorus-rich waters flow to the surface from wind-driven circulation. The nutrient-rich waters increase phytoplankton productivity creating an oxygen minimum zone (OMZ) with available dissolved iron. Southern Indiana is home to a deposit of phosphate rock that formed in a drastically different environment. Throughout much of the Ordovician (488.3-443.7 Mya), Indiana was partially submerged by a shallow (~10m-150m deep) tropical inland sea. The area was situated approximately 20^{o} south of the equator in a position that would be similar to modern-day Brazil, as a member of the ancient landmass called Laurentia. The oxygen concentrations of the inland sea control phosphatization and the materialization of other minerals, including pyrite (FeS_2). Pyrite formation is fundamental to geochemical proxies used to determine seawater and sediment traits in ancient environments. It can be formed through a variety of pathways including direct precipitation, solid monosulfide conversion, hydrogen sulfide (H_2S) reaction, and iron loss preceding oxidation. The distinct mechanisms driving pyrite formation can be determined through the isotopic signature and the abundance of sulfide released through chromium reducible sulfur (CRS) methods. This study seeks to better understand the ancient water column and pore water characteristics of Ordovician Indiana. We present pyrite concentration isotope data and total phosphorous data to better understand the environmental conditions under which these sediments formed. Identifying these characteristics will add significantly to existing knowledge on phosphate accumulation independent of the oceanic upwelling model.

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